Brookhaven National Laboratory
Fire Protection Engineering
Bldg. 599
Upton, New York 11973

Fire Protection Engineering

# Exemption Request for Fire Barriers at PHENIX & STAR Experimental Halls

*Prepared by J. Levesque*

January 27, 1999, Revision 1

**Department of Energy**
Brookhaven Group
Building 464
P.O. Box 5000
Upton, New York 11973

APR 2 6 1999

Dr. Satoshi Ozaki
Brookhaven Science Associates, LLC
Brookhaven National Laboratory
Upton, New York, 11973

Dear Dr. Ozaki:

**SUBJECT: EXEMPTION REQUEST FOR FIRE BARRIERS AT THE STAR AND PHENIX EXPERIMENTAL HALLS AT RHIC**

Reference: Letter, S. Ozaki, BNL to M. Holland, BHG, Dated January 21, 1999, Subject: Same as above

BHG has completed reviewing the exemption request for the fire barriers at STAR and PHENIX experimental halls per your request of January 21, 1999. In support of our review we enlisted the expertise of the Chicago Operations Office (CH). Following the resolution of all CH comments, BHG requested comments from the Office of Science (SC) and the office of Environment Safety and Health (EH) as required by DOE M 251.11-1A. Both EH, in their letter of March 8, 1999, and SC in their letter of March 22, 1999, have concurred in granting this exemption. Therefore, I approve this exemption request.

With approval of this exemption I will request unconditional Low Hazard Classification for the RHIC detectors from the Director, Office of Science.

Should you have any questions please contact Michael Butler the RHIC Project Manager on 344-3430.

Sincerely,

George J. Małosh
Brookhaven Group Manager

cc: D. Kovar, SC-23, GTN
J. Bisognano, SC-23, GTN
D. Nelson, SC-83, GTN
J. Zamirowski, TAS, CH
T. Sheridan, BNL
H. Kahnhauser, BNL
S. Musolino, BNL
M. S. Davis, BNL

DOE F 1325.8
(08-93)

United States Government **Department of Energy**

# memorandum

DATE: MAR 08 1999

REPLY TO ATTN OF: The Office of Occupational Safety and Health Policy:Kubicki:3-4794

SUBJECT: EXEMPTION REQUEST FOR THE RELATIVISTIC HEAVY ION COLLIDER (RHIC) AT BROOKHAVEN NATIONAL LABORATORY (BNL)

TO:

George J. Malosh, Manager
Brookhaven Group

This responds to your memorandum of February 19, 1999, in which you provided information on a pending exemption request for our review and comment. As expressed in the memorandum, it is your intention to approve the exemption unless we express objections. We concur with your decision and have elected to respond in writing to avoid any uncertainty.

The exemption relates to the lack of a continuous fire-rated barrier between the RHIC tunnels and the STAR and PHENIX experimental halls. We agree with the engineering analysis that was provided by the BNL fire protection staff. This assessment concluded that sufficient fire protection exists for the building to compensate for this condition. It would not be realistic or cost-effective to construct a fire barrier in this location that literally meets the Department's fire safety directives that are applicable to this project.

If there are any technical questions related to this correspondence, please contact Mr. Dennis Kubicki of my staff on 301-903-4794.

Joseph E. Fitzgerald, Jr.
Deputy Assistant Secretary
Worker Health and Safety

cc:
David Michaels, EH-1
M. Johnson, SC-80
M. Cole, SC-83
J. Zamirowski, CH
R. Diem, BAO
F. Marotta, BNL
J. Levesque, BNL

## Introduction

This document outlines the basis for requesting an exemption request for two of the experimental halls and the RHIC Tunnel. DOE Orders require Brookhaven National Laboratory (BNL) to provide fire rated walls to protect multi-million dollar facilities from adjacent occupancies. Tunnels, without segregating fire barriers, connect both the STAR and PHENIX Detectors.

There are multiple compensatory factors that mitigate the risk and are listed in this document. Referenced documents also provide a basis for DOE facilities obtaining prior approval for exemption requests.

## Citation

DOE Order 420.1 requires proper protection against:

> "... property losses from a fire and related events should be prevented from exceeding defined limits established by DOE."

DOE STD-1066.97, "DOE Standard, Fire Protection Design Criteria." establishes these limits in Paragraph 5.1.2, which states:

> "When the MPFL (Maximum Possible Fire Loss) exceeds $150 Million, a redundant fire system and 3 hour fire barrier should be provided to limit the MPFL to acceptable levels as determined by the AHJ (Authority Having Jurisdiction)."

## Reference documents

September 1998 "Fire Hazard Assessment/ Analysis of Building 1008, 1008A, PHENIX Experimental Complex"

September 1998 "Fire Hazard Assessment/ Analysis of Building 1006, 1006A, STAR Experimental Complex"

Relativistic Heavy Ion Collider Safety Assessment Document, January 1999 Draft

November 28, 1990 "Exemption from the Criteria of DOE Order 5480.7, 'Fire Protection' for the Advanced Light Source (ALS) Project," to Donald W. Pearman Jr., Manager San Francisco Operations Office, approved by Paul L. Zimmer, Assistant Secretary, Environment, Safety & Health

February 19, 1991 "Exemption from the Fire Separation Criteria in DOE/EP-0108 "Standard for Fire Protection of DOE Electronic Computer /Data Processing Systems" in Building 175 at Lawrence Livermore National Laboratory," to Donald W. Pearman Jr., Manager San Francisco Operations Office, approved by Paul L. Zimmer, Assistant Secretary, Environment, Safety & Health

February 12, 1993 "Exemption Request from the Requirement of DOE Order 5480.7 Pertaining to Fire Protection for the Replacement Tritium Facility (Ref.: SRS-DOE-5480.7-EX29)," to Everet H. Beckner, Acting Assistant Secretary, DP-1, approved by Peter N. Brush, Acting Assistant Secretary Environment, Safety & Health

# Discussion

## General Descriptions

Two of the experimental halls at the Relativistic Heavy Ion Collider (RHIC) contain the STAR Detector (Bldg. 1006) and the PHENIX Detector (Bldg. 1008).

For explicit details on the facility's construction, fire protection systems, BNL support systems, and detector system evaluations, please refer to STAR Fire Hazard Assessment/Analysis and RHIC Safety Assessment Documents listed the Referenced Documents Section, at the beginning of this report.

## Reason for Request

The construction of a fire rated partition would obstruct and restrict operations within the RHIC Tunnel. The actual construction of the wall would have several penetrations that would not be fire rated, such as the two collider magnet strings and the cryogenic lines. Although the wall is not a major cost issue, it is reasonable to expect that it will have to be removed over the next few years to allow movement of magnets. Due to the restricted width of the tunnel and the physical dimensions of the magnets, fires rated openings capable of accommodating the magnets are impractical. A more significant inconvenience will be the running of replacement and new cables through the fire rated wall. Cables penetrations require special fire rated seals that are very difficult to maintain and make installation of new cables difficult. These issues make the wall undesirable given the low benefit derived from the fire wall installation, as detailed in this document.

## Tunnel Connecting STAR and PHENIX

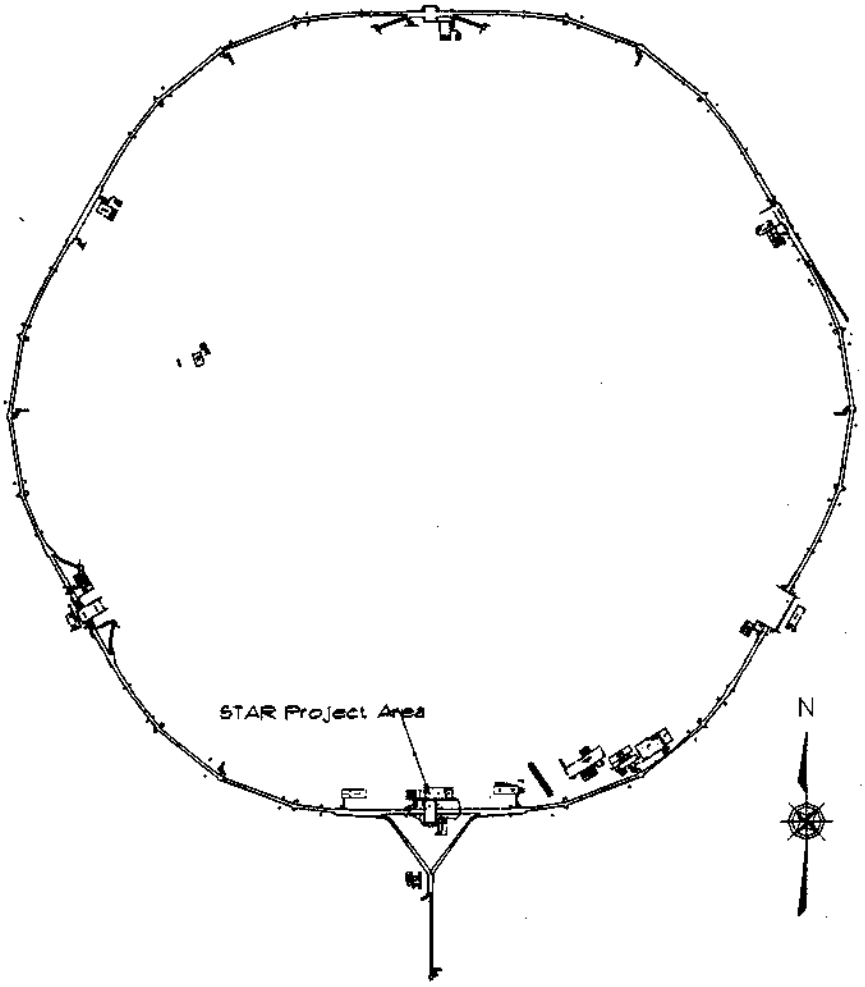
Between Bldgs.1006 and 1008 are tunnels used to circulate the beam around the RHIC facility. These tunnels are for the most part twelve feet in diameter. They all have concrete floors with corrugated steel circular arches forming the roof and walls. Within these tunnels are the two strings of cryogenic magnets (steel enclosed, copper coiled magnets with super-insulation and epoxy binding the coils). Cable trays run above the magnet strings providing signal and control functions. All cables are less flammable, either IEEE-383 qualified or UL Listed for Tray Cable use (which now includes flame propagation limitations). Cable tray fires are historically low heat release, smoky fires, that progress in a very slow manner.

The tunnel is provided with smoke detection. An overlaying heat detection system has been provided as a backup system. Manual fire alarm pull boxes are installed at exits and midpoints between exits. Activation of the tunnel fire alarm system activates an engineered smoke removal system (make up vents open and exhaust fans run producing approximately 100 lfpm flow down the tunnel).

Total replacement value of the magnets, power supplies, and cable in the RHIC Accelerator is over $85 million dollars (300 dipoles at $100k each, 300 CQS at $150k each, 18 alcoves at over $500k each).

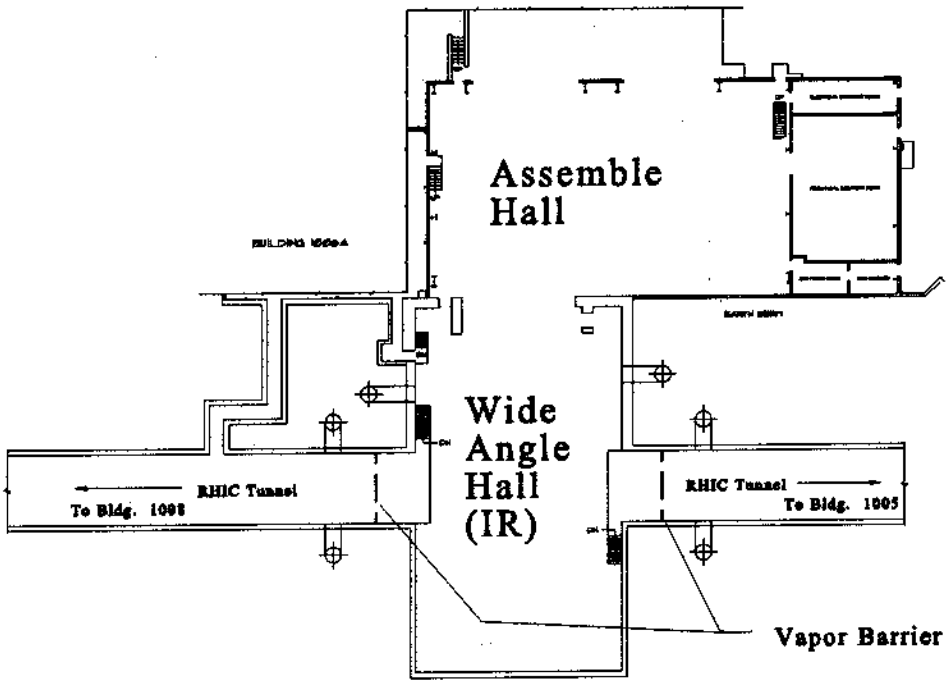
## The STAR Detector

The STAR Detector is housed in Building 1006 at the 6 o'clock position in the RHIC Accelerator Ring (see figure below). The total estimated dollar value to replace the Detector is over $27 Million dollars, while design and construction is estimated over $34 million.




KEY PLAN
NOT TO SCALE

Building 1006, which contains the STAR detector, is shown below:




The STAR detector resides in the center line of the tunnels passing through the Wide Angle Hall during accelerator running times. The Detector is a large solenoid magnet. Within the magnet gap is the Time Projection Chamber (TPC). The highest hazard is the P-10 gas (10% methane and 90% argon) within the TPC. P-10 is considered by the Department of Transportation as a non-flammable gas. However experience within BNL has shown that it can burn locally. . The lower explosive limit and the upper explosive limit are the same point, so any dilution beyond the initial burning point makes the gas non-flammable. A flammable gas detection system has been installed on the detector to detect leaks. This is also redundant to process control systems that are extremely sensitive to leaks. The TPC is constructed out of aluminum. It is pressurized to less than one inch of water column. This low-pressure system is not expected to have a large release. Due to the dilution of methane by the argon, it does not have a large heat release rate when it does combust.

The Building is provided with ceiling level wet pipe sprinkler protection, ceiling level heat detection, and ceiling level Highly Sensitive Smoke Detection. The detector is provided with Highly Sensitive Smoke Detection. High valued racks on the Detector are provided with clean agent suppression systems and in rack smoke detection/rate compensated heat detection.

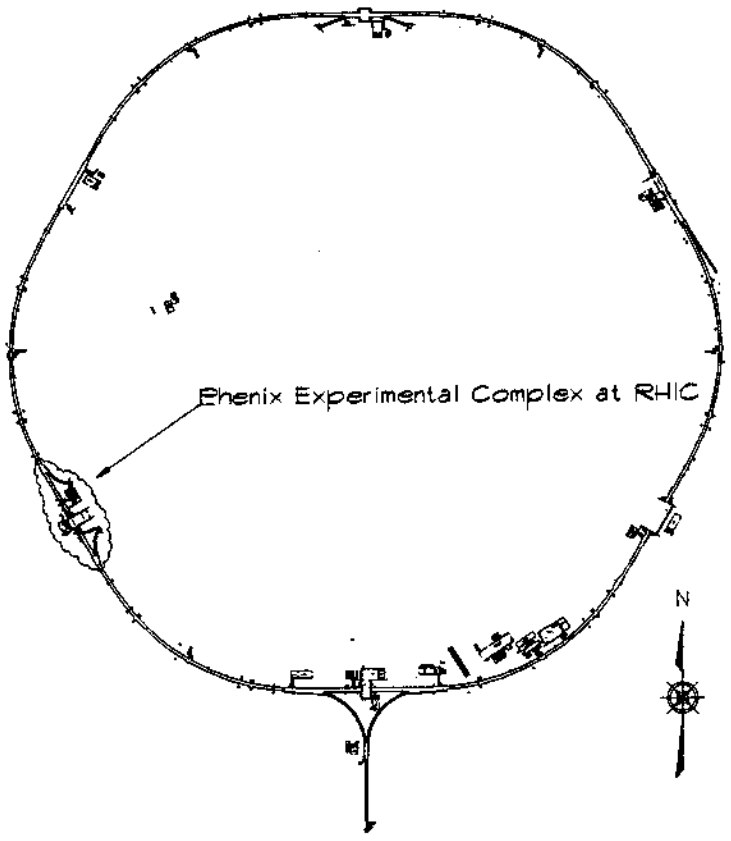
The building is also provided with a smoke removal ventilation system. This is activated by the smoke and gas detection systems.

To protect the Detector hall from the potential intrusion of Helium from a cryogenic release involving the super conducting magnets, a "herculite" vapor barrier was installed across both tunnel openings. While this is not meant to be smoke tight, it does limit smoke movement down the tunnel.

In front of the tunnel openings for PHENIX there are steel plates used as muon sheilding. These plates are a few inches thick and overlap the opening. The plates stand 8 inches away from the tunnel face creating a gap. The beamline also penetrates the opening through a 4' by 4' (approximate) opening in the center.

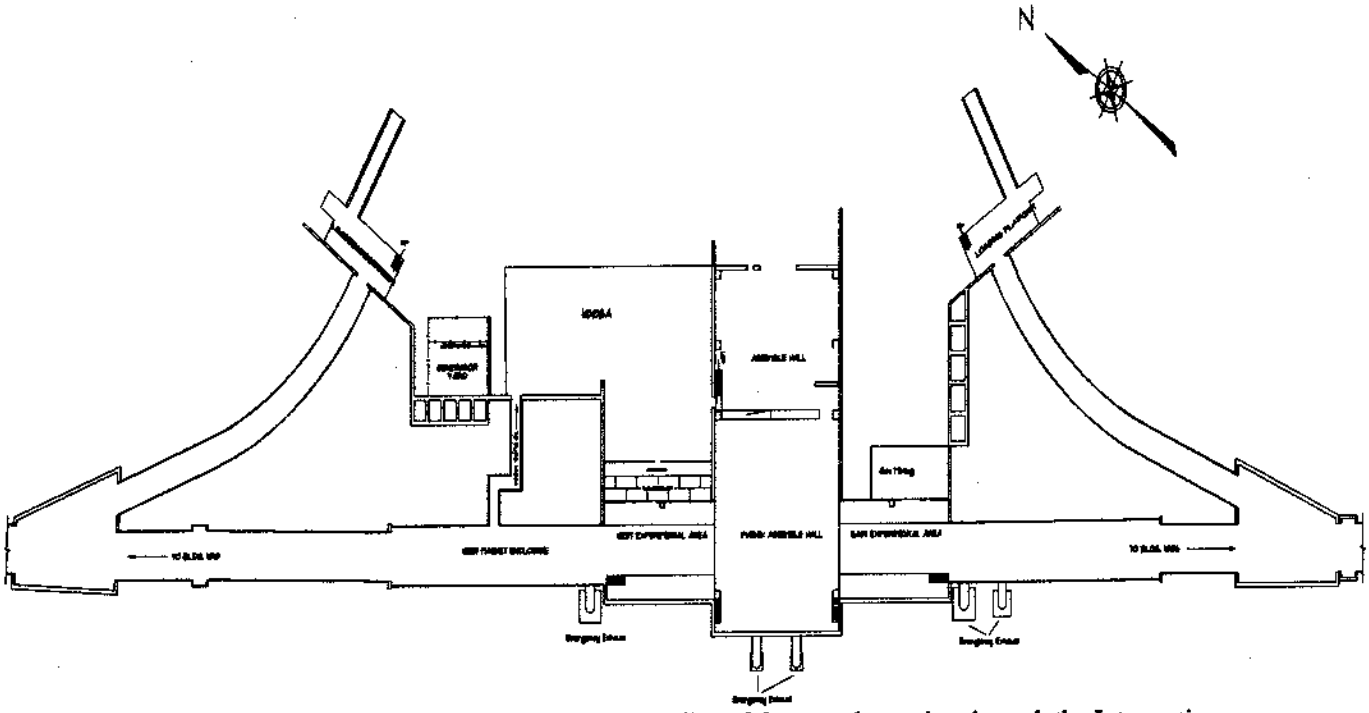
## PHENIX Detector

The PHNIX Detector is housed in Building 1008 at the 8 o'clock position in the RHIC Accelerator Ring (see figure below). ). The total estimated dollar value to replace the Detector is over $43 Million dollars, while design and construction is estimated over $58 million.




KEY PLAN
NOT TO SCALE

Building 1008, which contains the PHENIX detector, is shown below:




The PHENIX detector resides in the centerline of the tunnels passing through the Intersection Region during accelerator running times. The Detector consists of several sub systems constructed around a central magnet.

The Building is provided with ceiling level pre-action sprinkler protection, ceiling level heat detection, and ceiling level Highly Sensitive Smoke Detection. The Detector is provided with Highly Sensitive Smoke Detection.

The building is also provided with a smoke removal ventilation system.

To protect the Detector hall from the potential intrusion of Helium from a cryogenic release involving the super conducting magnets, a herculite vapor barrier was installed across both tunnel openings. While this is not meant to be smoke tight, it does limit smoke movement down the tunnel.

## Summary

Mitigating features to allow the omission of a fire rated barrier wall between the Detectors at RHIC and the tunnel are as follows:

1) The tunnel is occupied by low fire hazard equipment. While the magnets are high value, they are encased in metal and not exposed to risk from high fuel load in the adjacent area.

2) Spot smoke detection in the tunnel will provide early warning of any ensuing electrical fire.

3) A redundant heat detection system is installed to add reliability to the detection of a significant event.

4) The Detector halls are provided with sprinkler protection, thereby providing suppression in case of an event in the Detector Halls.

5) Highly Sensitive Smoke Detection is provided in the Detector Halls to allow early intervention of a problem in the halls.

6) Redundant heat detection is provided in the halls to ensure another level of detection is present.

7) Tunnel detection will actuate smoke removal systems in the tunnel to prevent intrusion of smoke into the halls.

8) Hall detection will actuate smoke removal systems in the hall to prevent intrusion of smoke into the halls.

9) The gases used in the halls are limited in volume and pressure. Leakage is not to be rapid and is unlikely to impinge into the tunnel.

10) The Halls represent a large volume. A fire has to be very significant to cause heat damage down the tunnel (the tunnel opening is low).

11) A vapor barrier is present at the entrances to the tunnels from the detector halls, further reducing smoke intrusion.

12) PHENIX has steel plates suspended in front of the tunnel openings. The steel overlaps the perimeter, but there is an eight-inch gap around the plate. The beamline also penetrates the plates with a 4' by 4' opening (approx.).